International Workshop on
International Collaboration Research using Monju

Fukui, Japan, 24-25 April 2013

IAEA R&D Activities in Support of the Innovative Fast Reactor Concepts and the Role of Monju

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Department of Nuclear Energy

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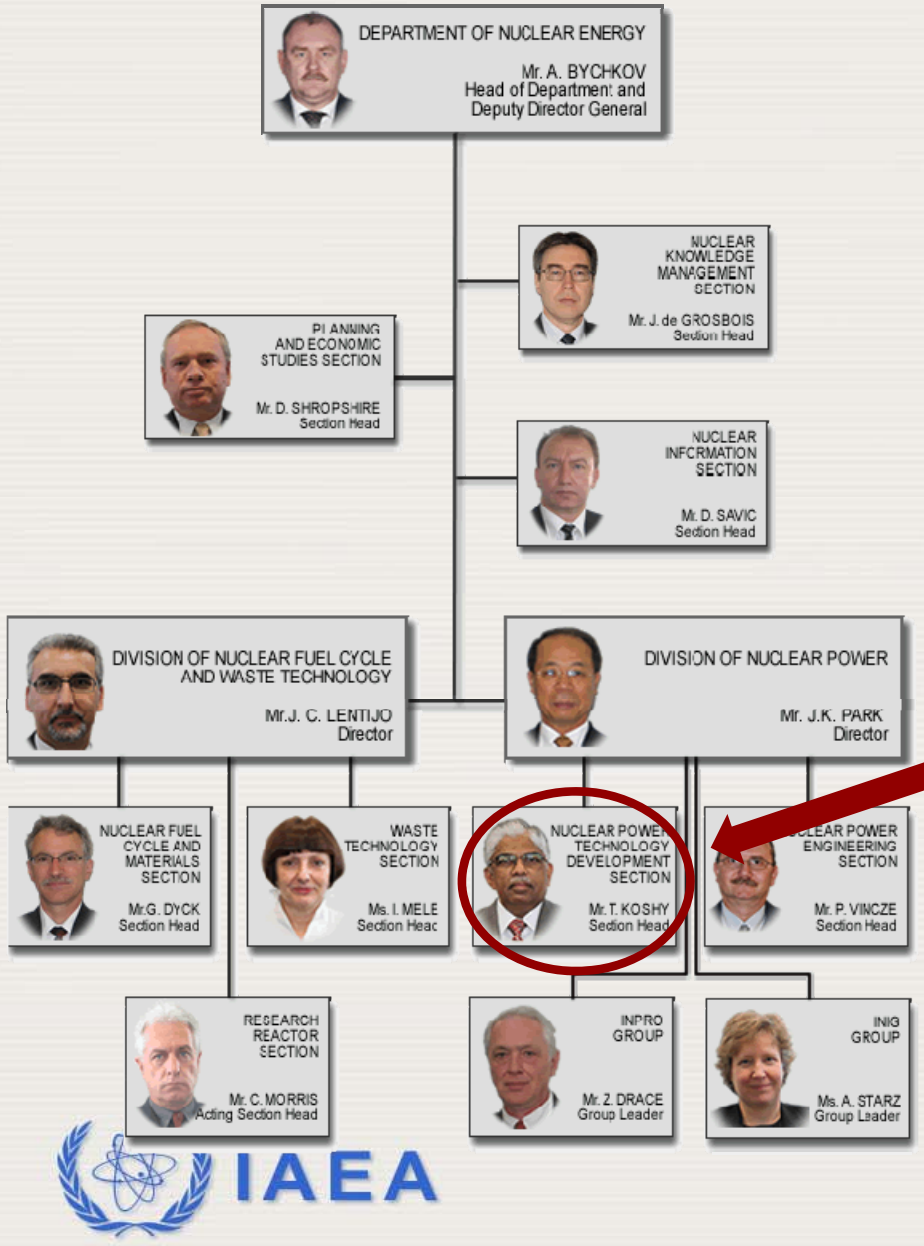
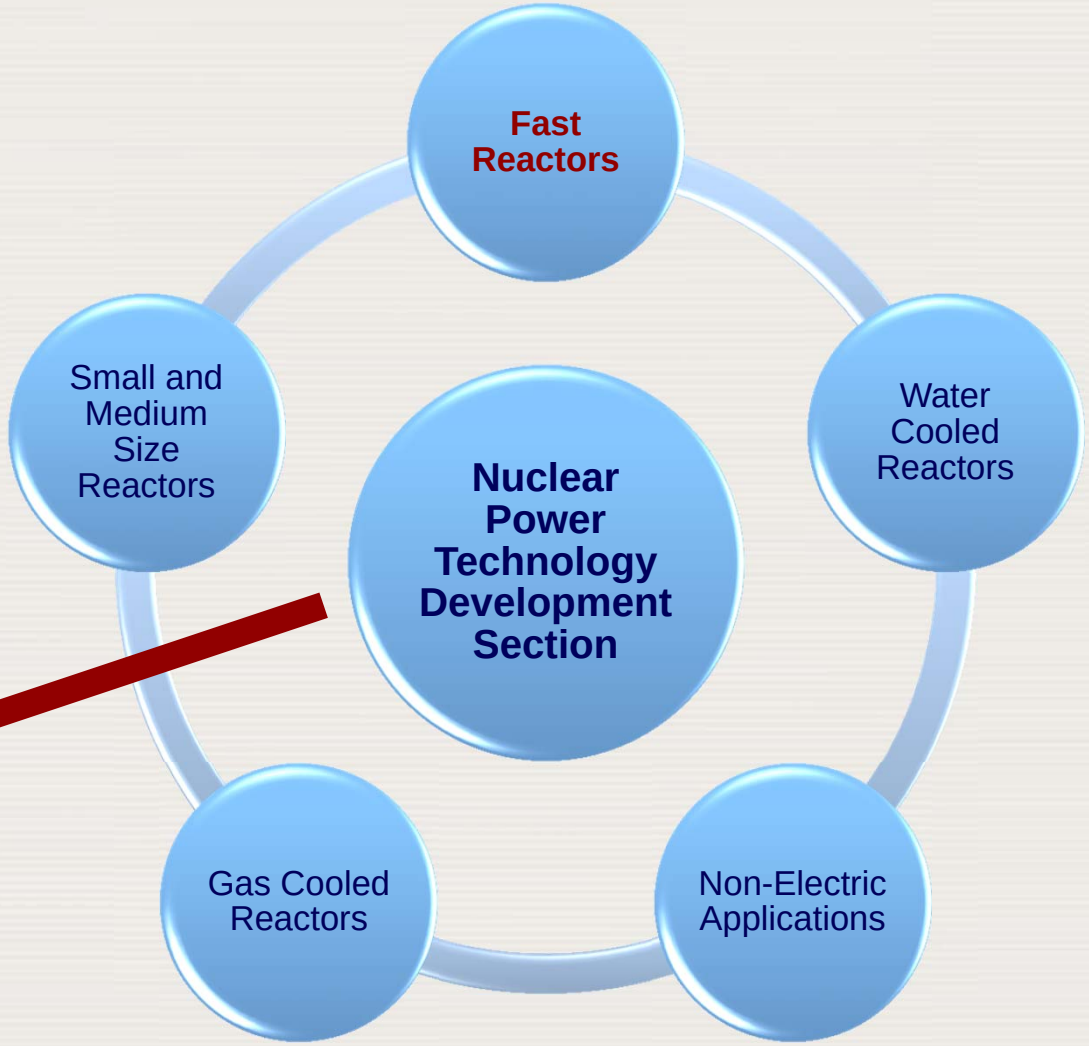
International Atomic Energy Agency

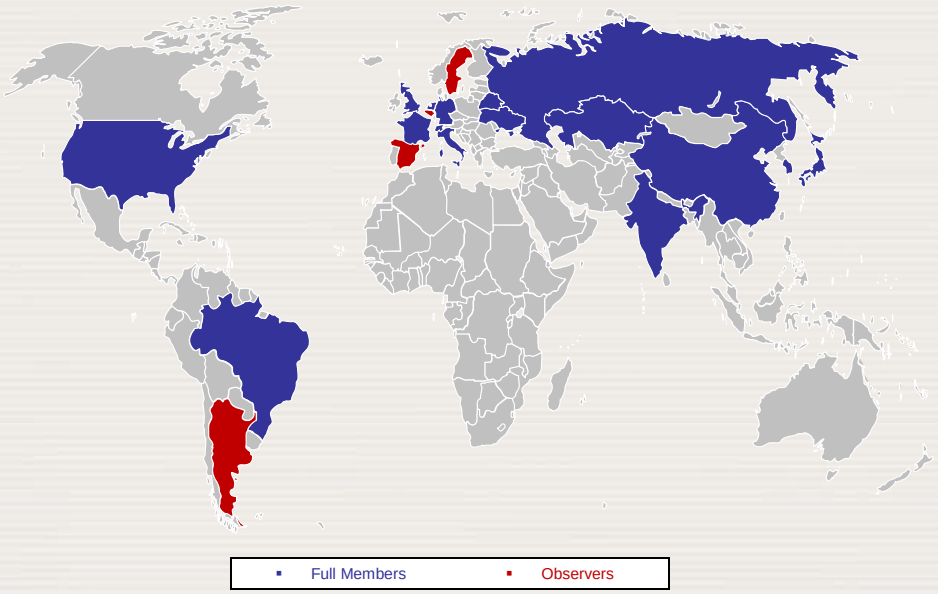
Framework of IAEA Activities in support of Fast Reactor Technology Development & Deployment





The IAEA Technical Working Group on Fast Reactors (TWG-FR)

Members of the IAEA Technical Working Group on Fast Reactors



Members of the IAEA Technical Working Group on Fast Reactors

Full Members	
Belarus	Brazil
China	France
Germany	India
Italy	Japan
Kazakhstan	Korea, Republic of
Netherlands	Russian Federation
Sweden	Switzerland
Ukraine	UK
USA	*European Commission*
OECD/NEA	
Observers	
Argentina	Belgium
Spain	

Participants in the
45th Annual Meeting
Argonne National Laboratory (USA)
20 – 22 June 2012

Forthcoming 46th TWG meeting
21-24 May 2013, Vienna, Austria

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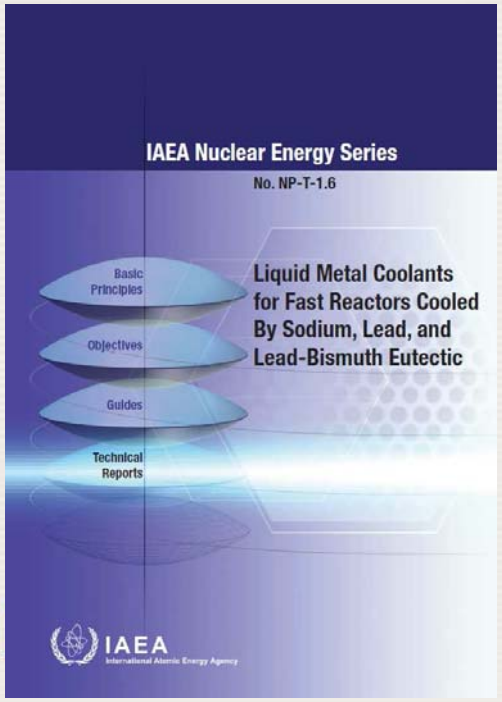
IAEA Activities on Fast Reactors: Technical Publications

- Background and overview
- Operating experience with SFR
- Sodium-cooled FR Designs
- HLM-cooled FR Designs
- Gas-cooled FR Designs
- Status of FR core R&D
- Reactor plant engineering technology development
- Reactor safety design and analysis
- National strategies, international initiatives, public acceptance and final remarks



Summary of the status of liquid coolants technology for fast reactors with regard to basic data, main technological challenges and the various fast reactor concepts and designs that are being investigated, with special emphasis on the choice of coolant

IAEA Activities on Fast Reactors: Technical Meetings & Workshops/Seminars

Recent Technical Meetings

- Fast Reactor Physics and Technologies
- Advanced Heat Exchangers & Steam Generators
- ISI&R
- Innovative FR with enhanced reactivity effects
- Lessons learned from Fukushima on safety of FR
- Identification of gaps for further FR development

Forthcoming Technical Meetings

- Existing and Proposed Experimental Facilities for Fast Neutron Systems (10-12 Jun 2013)
- Liquid Metal Reactor Concepts: Core Design and Structural Materials (12-14 Jun 2013)
- Fast Reactors with Improved Economics and Enhanced Non-proliferation Characteristics (Sept 2013)

International Workshops

- IAEA-JAEA- Workshop on Prevention and Mitigation of Severe Accidents in SFR (Fukui, June 2012)
- GIF-IAEA/INPRO WS on safety design criteria for SFR (IAEA, February 2013)

E & T Seminars / Schools

- Education and Training Seminar/Workshop on Fast Reactor Science and Technology
- School on Physics, Technology and Applications of Innovative Fast Neutron Systems and Related Fuel Cycles (Sept 2013)

FR Data Retrieval & Knowledge Preservation

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For more information: http://www.iaea.org/NuclearPower/FR

FR13 Conference in numbers

- Total number of participants: 642
- Participating countries: 27
- International Organizations: 4
- Plenary sessions 4
  - ✓ *National and International Programmes*
  - ✓ *Safety Design Criteria*
  - ✓ *Sustainability of Advanced Fuel Cycles*
  - ✓ *Young Generation Event*
- Topical Tracks: 10
  - ✓ *Technical Sessions (oral presentations) 41*
  - ✓ *Poster Sessions* 2
- Scientific Contributions: 365
  - ✓ *Oral presentations: 208*
  - ✓ *Poster presentations:* 157

All the presentations available at:

http://www.iaea.org/NuclearPower/Meetings/2013/2013-03-04-03-07-CF-NPTD.html

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FR13 Conference: Papers on Monju

Family Name	First Name	Topical Track	Title	Type
Kondo (Mr)	Shunsuke	Plenary Session	Deliberation of Post 3.11 Fast Reactor R&D Strategy in Japan	Paper
Deshimaru (Mr)	Takehide	Track 3 Safety	Recent Progress and Status of Monju	Paper
Okawa (Mr)	Tsuyoshi	Track 7 Simulation	Fuel Behavior Simulation Code FEMAXI-FBR Development for SFR Core Disruptive Accident Analysis	Paper
Haga (Mr)	Kazuo	Track 3 Safety	A Probabilistic Safety Analysis on Fuel Subassembly Events of Monju	Poster
Ohira (Mr)	Hiroaki	Track 7 Simulation	Benchmark Analyses of Sodium Natural Convection in the Upper Plenum of the MONJU Reactor Vessel	Paper
Kitano (Mr)	Akihiro	Track 9 Operation	Evaluation of Feedback Reactivity in Monju start-up test	Poster
Yamada (Mr)	Fumiaki	Track 9 Operation	Evaluation on Coolability of the Reactor Core in Monju by natural circulation under Earthquake and subsequent Tsunami event	Paper
Kikuchi (Mr)	Norihiro	Track 7 Simulation	Application of statistical method for FBR plant transient computation	Poster
Umebayashi (Mr)	Eiji	Track 2 Components	Safeguards in Prototype Fast Breeder Reactor Monju	Paper
Kato (Ms)	Yuko	Track 3 Safety	Control Rod Worth Measurement in Monju Restart Core	Poster
Aoyama (Mr)	Takafumi	Track 2 Components	Study on High Sensitive FFDL Technique for Monju and next generation SFR Using Laser Resonance Ionization Mass Spectrometry	Paper
Mochizuki (Mr)	Hiroyasu	Track 7 Simulation	CFD computation of thermal stratification in the upper plenum of Monju reactor	Poster

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IAEA Coordinated Research Activities on FRs

- One of the main tasks of the IAEA is to regularly launch and organize – under the Member States' advise - Coordinated Research Projects in order to carry out research activities in support to the development of different nuclear technologies
- In particular CRPs are being carried out in order to verify and validate computer codes developed by the Member States, on the basis of experimental data coming from tests performed in existing reactors
- These simulation tools are used for the design and the system and safety analysis of innovative reactors, in particular Generation IV Sodium-cooled Fast Reactors

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IAEA Coordinated Research Activities on FRs

CRPs on Fast Reactor Technology

CRPs recently completed

Analytical and Experimental Benchmark Analyses of Accelerator Driven Systems (ADS)

Analyses of, and Lessons Learned from, the Operational Experience with Fast Reactor Equipment and Systems

Control Rod Withdrawal and Sodium Natural Circulation Tests Performed During the PHENIX End-of-Life Tests

Benchmark Analyses of Sodium Natural Convection in the Upper Plenum of the MONJU Reactor Vessel

CRPs currently on-going

Benchmark Analyses of an EBR-II Shutdown Heat Removal Test

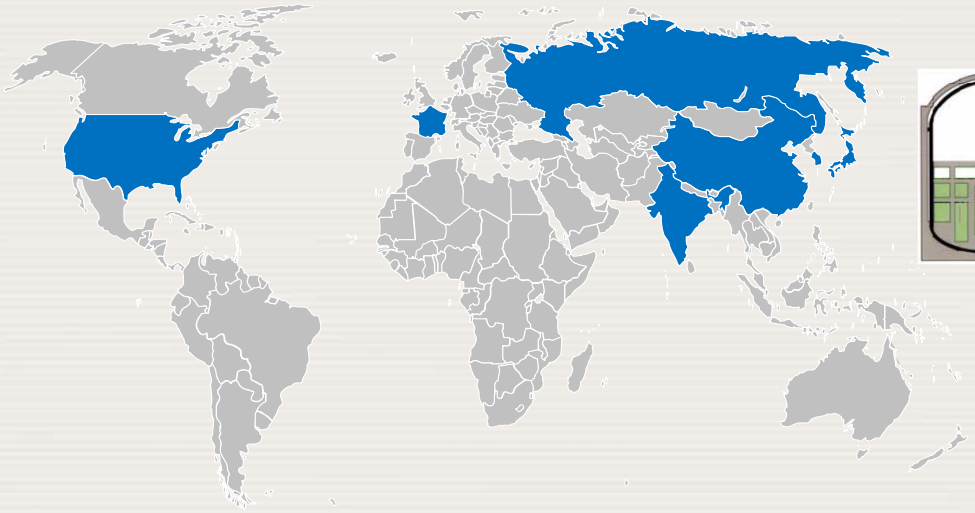
Sodium Properties and Design and Safe Operation of Experimental Facilities in Support of the Development and Deployment of Sodium-cooled Fast Reactors (SFR) - NAPRO

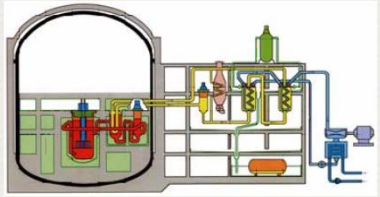
CRPs planned

Source Term for Radioactivity Release Under Fast Reactor Core Disruptive Accident (CDA) Situations

Benchmark exercise on Neutronic Calculations for a Mixed-oxide Fuelled Core of an Industrial Size Sodium-cooled Fast Reactor

CRP on Benchmark Analyses of Sodium Natural Convection in the Upper Plenum of the Monju Reactor Vessel



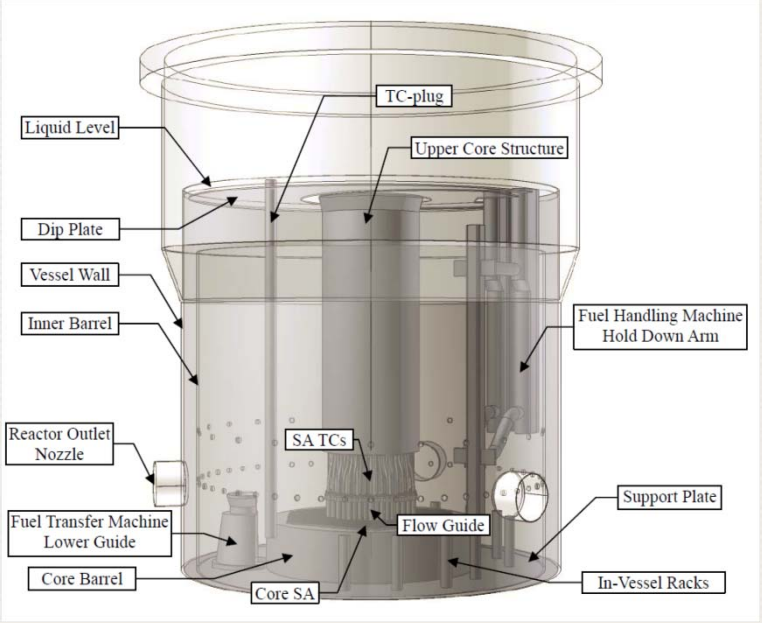


"Benchmark Analyses of Sodium Natural Convection in the Upper Plenum of the MONJU Reactor Vessel"

Participants

China (CIAE)	France (CEA)
India (IGCAR)	**Japan (JAEA & Fukui Uni.)**
Korea, Republic of (KAERI)	Russian Federation (IPPE)
USA (ANL)	

- Carried out between 2008 and 2012 (*last RCM in Tsuruga, 16-19 April 2012*)
- Validation of T/H codes on the basis of the Na thermal stratification measurements performed in MONJU during a reactor turbine trip test conducted in December 1995 in the course of the original system start-up tests



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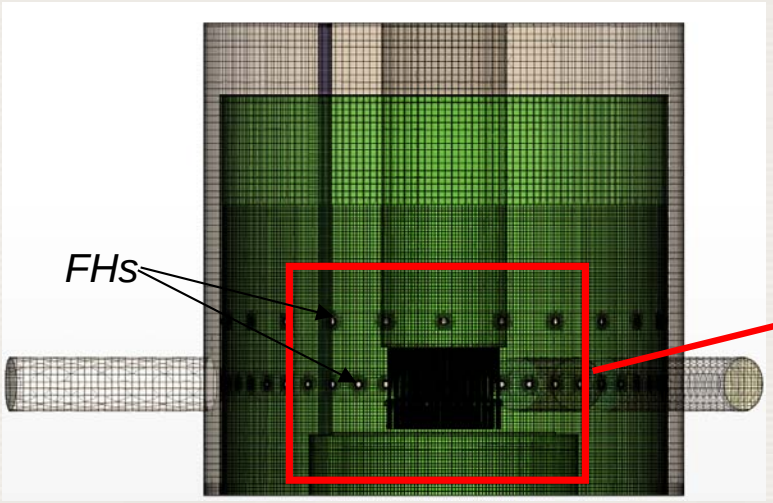
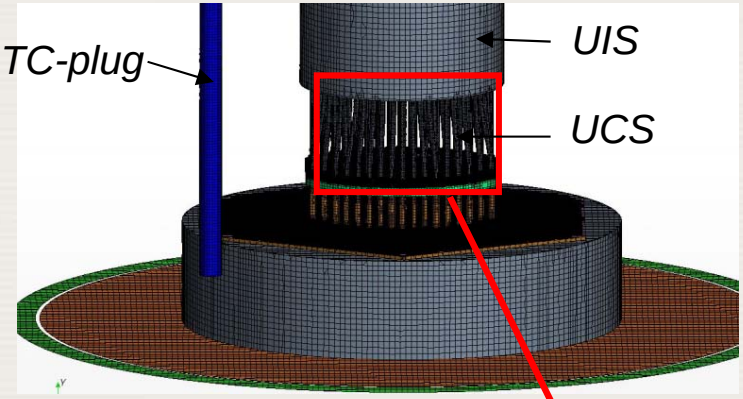
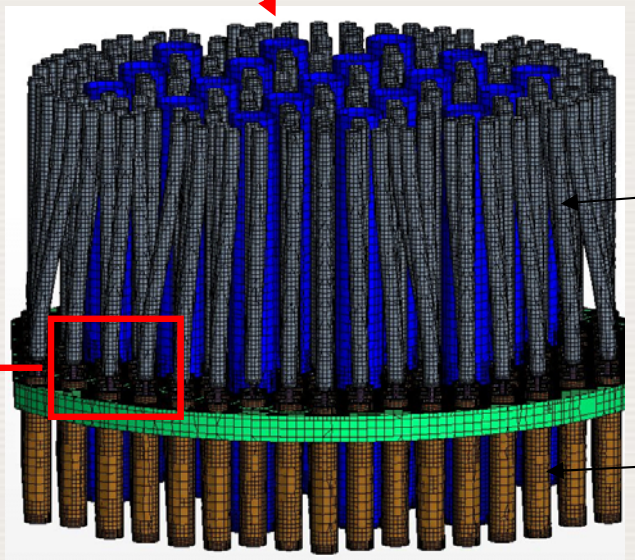
Complex geometry of the upper plenum of the Monju RV: Full sector models with high resolution meshes



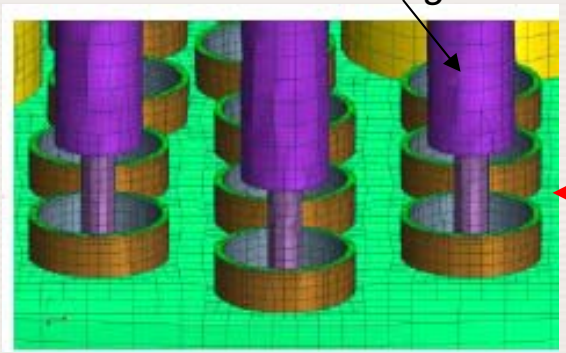
Upper plenum of MONJU RV



Core barrel and UCS



Fingers and FGTs



Fingers and FHs on HS

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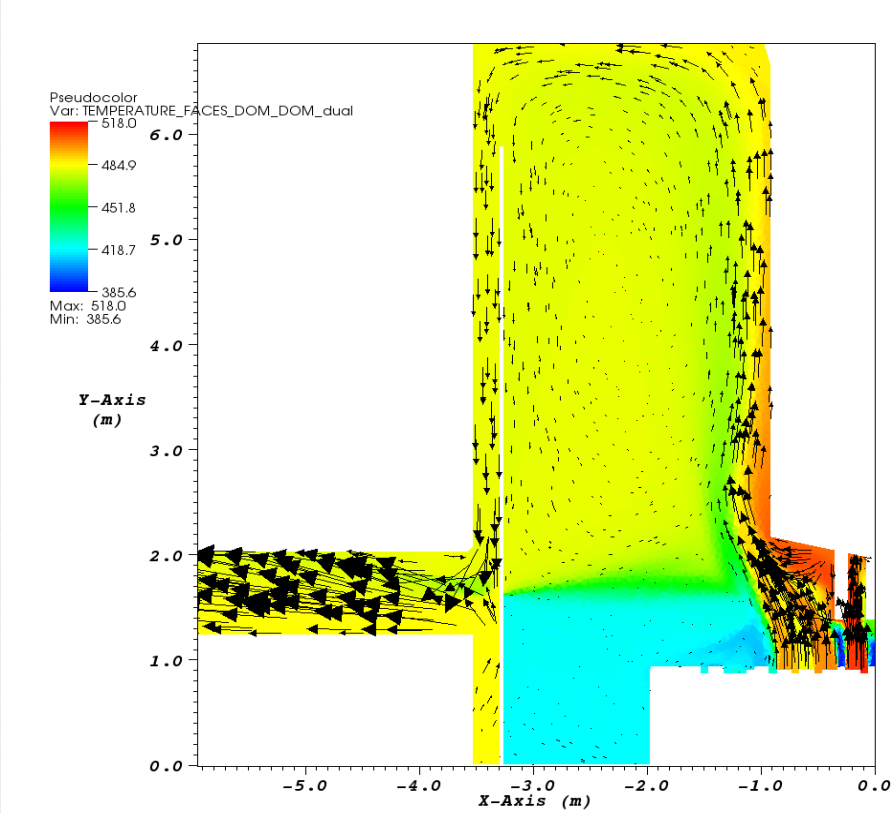
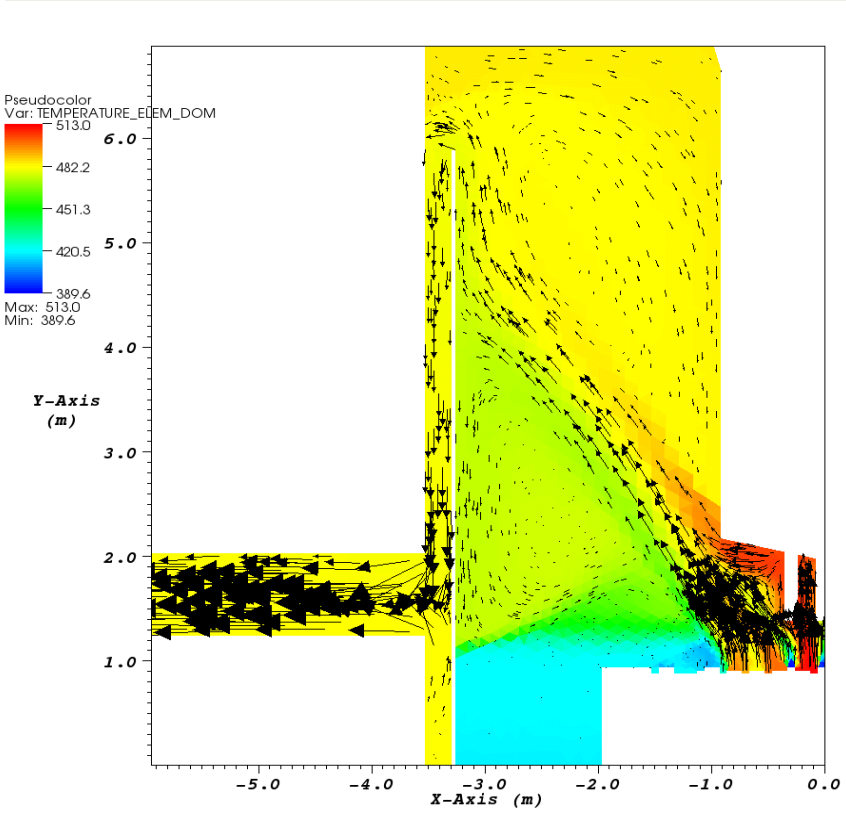
Steady State Solutions:

Temperature and velocity distribution in the upper plenum



Buoyancy driven solution



Momentum driven solution

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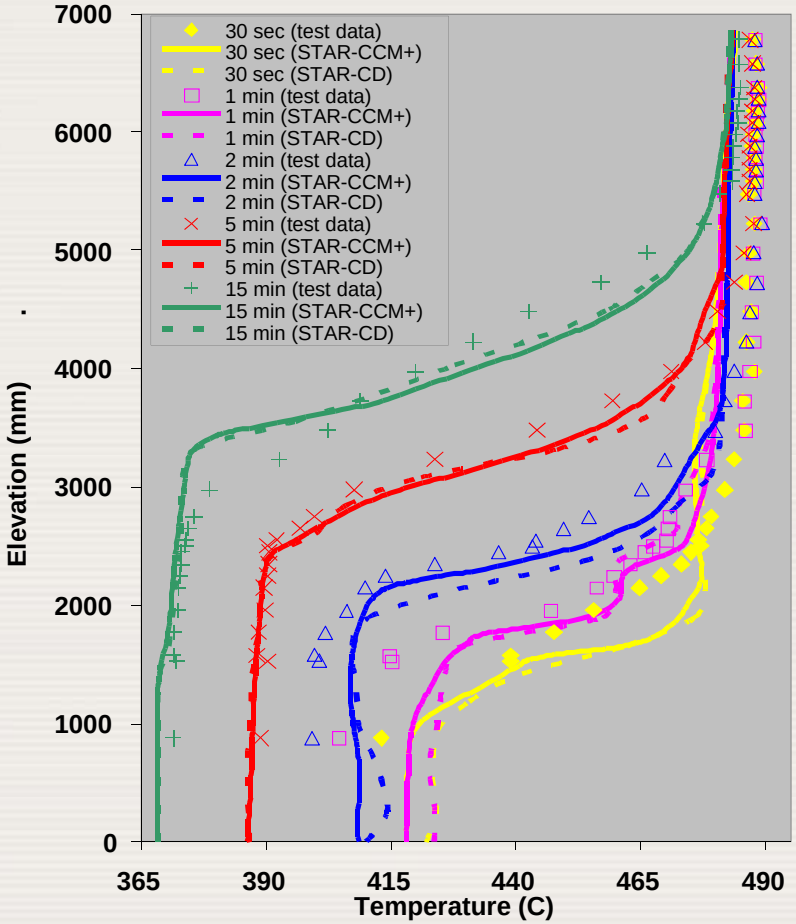
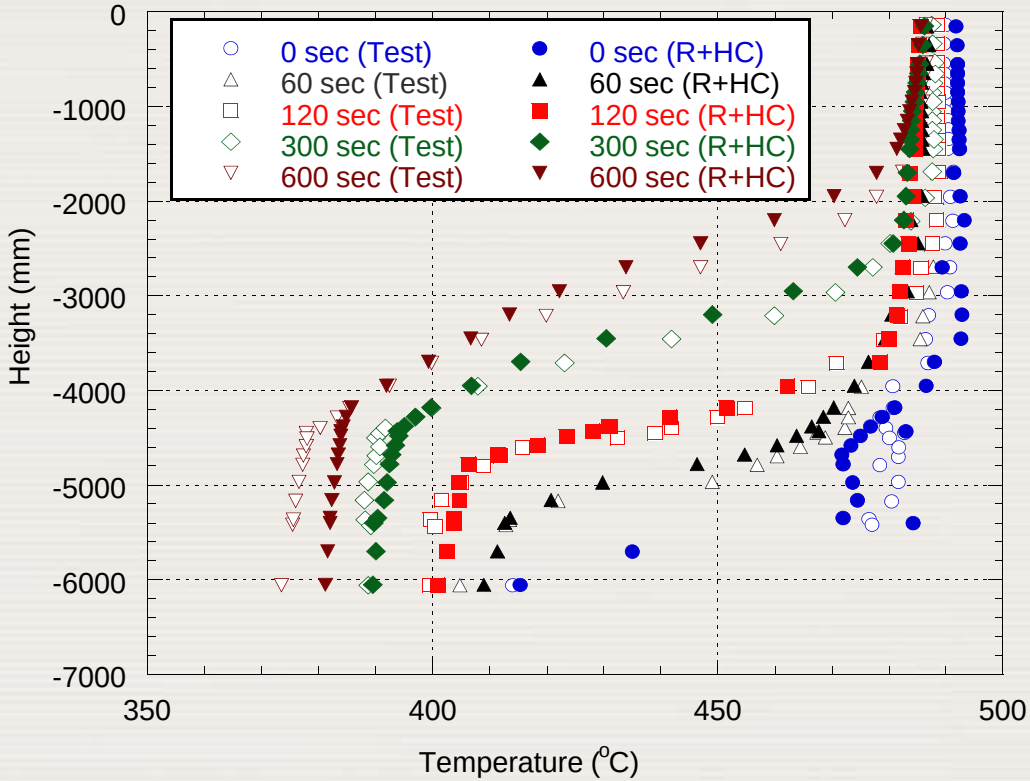
Dynamic calculations:
Calculated and measured temperature distribution on TC-plug



Results of simplified model
(calculated by ANL)



Results of full sector model
(calculated by U. of Fukui)

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IAEA Monju CRP: a case of success

- Analytical capabilities of the participating organizations in the field of fast reactor in-vessel sodium thermal hydraulics were improved (*challenging issues due to the complex geometry of MONJU and the involved phenomena*)
- Key parameters that affect the thermal stratification phenomena in the upper plenum of advanced SFRs were identified
- From the statement delivered during the post-RCM Workshop at the University of Fukui on 19 April 2012: "*All the participants, including the IAEA, have expressed their full satisfaction as far as the results obtained so far, since they have allowed a better understanding of the complex phenomena involved in the experimental test carried out in Monju, as well as of the performances and limits of the different simulation tools available today to the international nuclear scientific community*"

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Role of Monju for the international scientific community

- From the statement delivered during the post-RCM Workshop at the University of Fukui on 19 April 2012: "…*taking into account that the Monju reactor represents the only available fast reactor in the world able to host large scale experimental tests at power, the scientific community participating in the IAEA CRP on "Benchmark analyses of Sodium Natural Convection in the Upper Plenum of the MONJU reactor" welcome the restart of this reactor and, as a consequence, the implementation of a new set of thermal-hydraulic tests which would provide experimental data of primary importance for the development of innovative Sodium-cooled Fast Reactors at international level*"

- From the key messages delivered to the press after the IAEA-JAEA International Workshop on Prevention and Mitigation of Severe Accidents in SFR (Tsuruga & Tokyo, 12-14 June 2012): "*The design of the prototype fast breeder reactor Monju is already incorporating evaluations of, and measures against, severe accidents based on the safety characteristics of SFRs. The restart and operation of Monju will provide the international SFR community with very useful experience to pave the way towards 4th generation SFR*"

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A new IAEA CRP based on new experimental data from Monju

- Natural Circulation Analysis in the Upper Plenum of Monju
- Potential participants: China, France, India, Japan, Republic of Korea, Russian Federation, USA
- To be launched in 2015-2016

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http://www.iaea.org/NuclearPower/FR/

Thanks for Your Attention !

…Atoms for Peace

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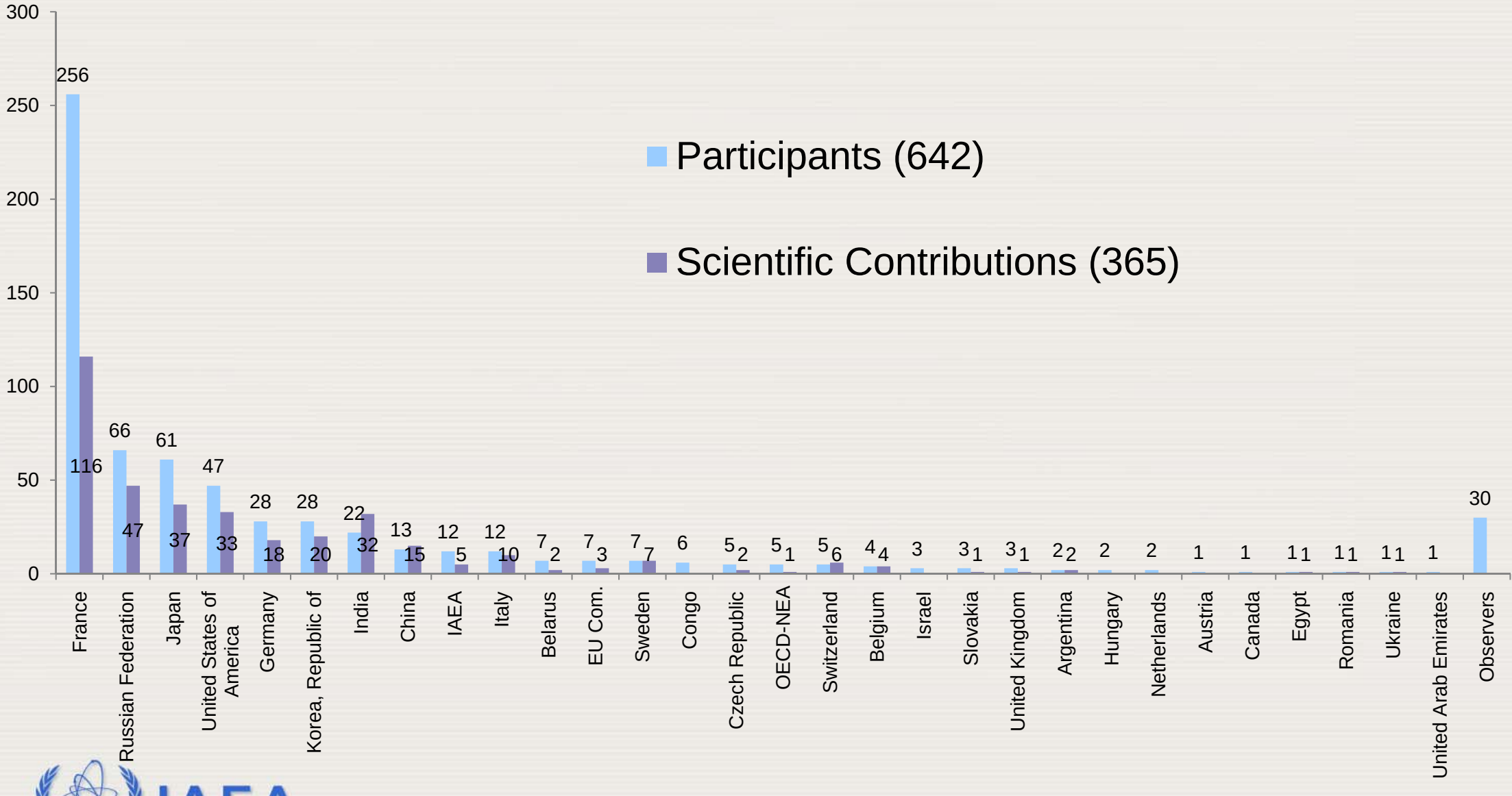
Back up

FR13 Conf.: Scientific Contributions per Country



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IAEA Coordinated Research Activities (CRA) and their implementation through Coordinated Research Projects (CRPs)

- Coordinated Research Activities should corresponds to IAEA's programmes, sub-programmes and projects (*for instance Fast Reactor Technology Development*)
- R&D: *primarily applied research*
- CRA implemented through Coordinated Research Projects (CRPs), which bring together research institutes in both developing and developed Member States to collaborate on research topics of common interest

- Scope
  - ✓ Contribute to capacity building primarily in developing countries
  - ✓ Address areas where IAEA coordination provides significant added value or represents a unique contribution
  - ✓ Relevant to Member States, and complementary to and promote synergy with the on-going national and international activities
  - ✓ Obtain new knowledge and better understandings of scientific and technical problems, and provide recommendations for their solution
  - ✓ Encourage networking among scientists and among institutes, to support transfer of knowledge between developed and developing countries

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CRPs implementation

- A network of 5-15 national research institutes represented by a Chief Scientific Investigator (CSI)
- Implemented through Research, technical and Doctoral Contracts
  - ✓ Research, technical and doctoral **Contracts**
  - ✓ Research **Agreements**
  - ✓ Research Coordination Meetings (**RCMs**).
- ✓ Funded from the regular budget but sometimes also from extra-budgetary contributions from interested Member States
- ✓ Have at least one clear and specific objective
- ✓ Results to be obtained in 3-5 years
- ✓ Large dissemination of results through IAEA TECDOC (to be approved by the IAEA Publications Committee not later than 12 months after CRP completion), book by an external publisher, international journals, IAEA web-site, etc.

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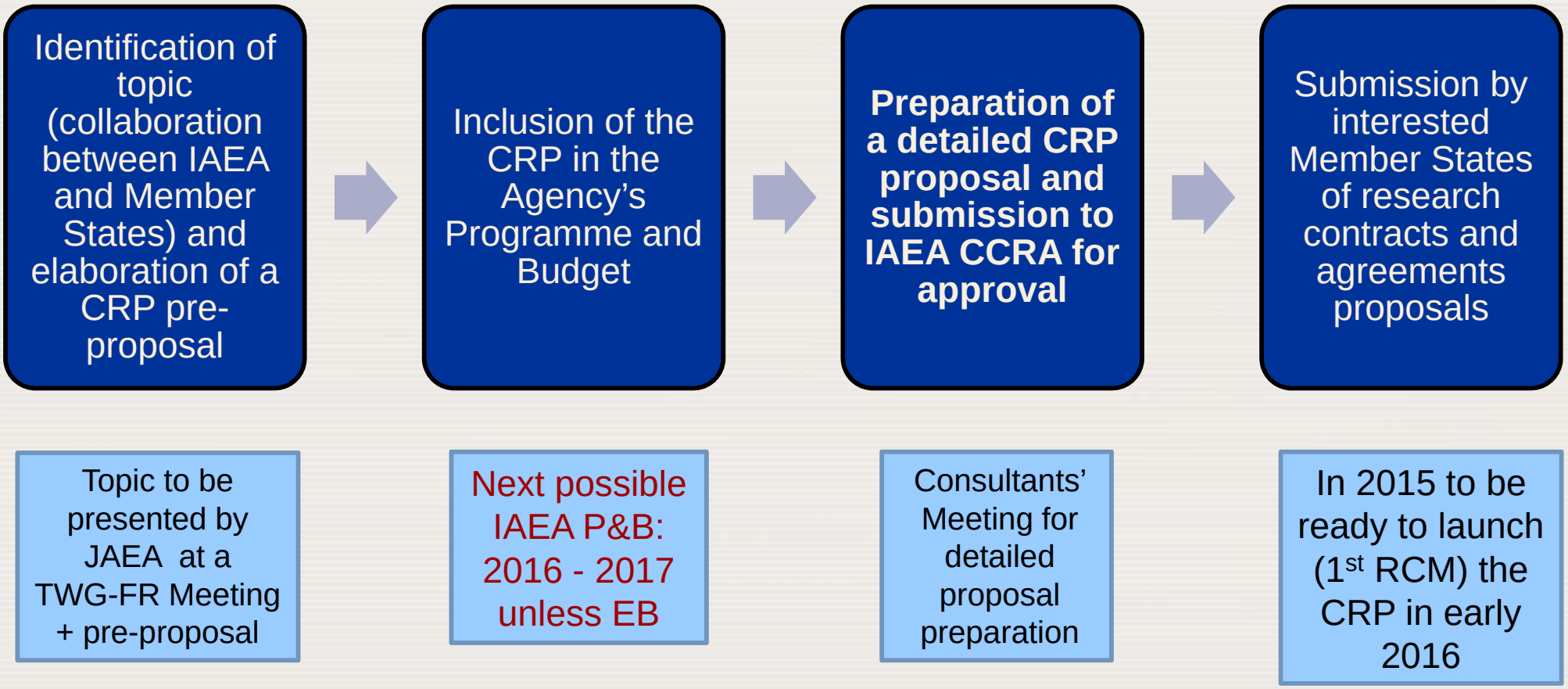
Main steps for planning new CRPs



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